

Investigations Of The Poleward Undercurrent Over The Continental Margin Along The Ocean's Eastern Boundaries

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LONG-TERM GOALS

Our goal is to determine the characteristics of poleward undercurrents, which are ubiquitously observed along the eastern margin of ocean basins, including their strength, structure, and variability, and to understand the dynamics controlling them.

OBJECTIVES

The objective of the present effort is to determine the velocity field and its mesoscale variability along the continental margin off North America, from Point Conception, CA to Vancouver Island, Canada, during the summer of 1998.

APPROACH

In July-August 1998, ADCP data were acquired during the triennial NOAA NMFS acoustic and trawl survey of Pacific whiting, which extended from 36 N to 52 N. Figure 1 indicates the geographical extent of leg 1 of the survey. Such a survey, while not synoptic along its whole domain, is locally synoptic, since integral time scales over the continental slope are typically 4 to 10 days, as observed with the Eastern Boundary Currents moored array.

WORK COMPLETED

Vertical profiles of ocean currents were collected during both legs of the Triennial Trawl Survey, using a downward-looking 150-kHz ADCP installed on the NOAA ship Miller Freeman. Because bottom-tracking data were not available (the bottom-tracking pings interfered with the acoustics used in the fish assessments), all profiles were hand-screened for bottom interference before further processing. Absolute currents were computed using differentially-corrected GPS data, after calibration and misalignment corrections were determined from the differences between on-station and underway currents. Preliminary maps of currents at fixed depths through the poleward undercurrent have been made.

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RESULTS

During July-August 1998, the Miller Freeman conducted a sequence of nearly 60 sections, crossing from the continental shelf to the mid-slope at latitudes from 36°N to 52°N, to bottom depths typically exceeding 1000m and often exceeding 2000m. The Freeman's ADCP performed well, with returns down to 370m exceeding 90% good during the long deep-water transit from Seattle to Monterey.

The near-surface flow (Figure 1, left panel) was dominated by a baroclinic equatorward current jet, with speeds up to 70 cm/s, as expected during the summer. This view of the summer jet is unusual in providing data over a wide range of latitudes. The equatorward jet showed a strong tendency toward offshore veering just north of the prominent coastal capes – e.g. at Cape Blanco (43°N), Cape Mendocino (40.5°N) and Point Arena (39°N).

By contrast, the currents at 150m between Monterey (36°N) and Cape Blanco (43°N) were dominated by the poleward undercurrent (Figure 1, left panel). Nearly 2/3 of these measured currents were directed poleward at 5 cm/s or greater, with the most common poleward speed being 10-20 cm/s. These results confirm the conclusion from the 1995 survey data (Pierce, et al., 1998) that the poleward undercurrent is a robust feature of the flow over the continental margin, and is continuous over long distances at these latitudes.

One of the most prominent disruptions in the flow of the undercurrent, and of the surface jet above it, is the anticyclonic eddy centered over the continental slope near 38.5N. The formation process for these features have been described using the Eastern Boundary Currents hydrographic and moored array measurements (Huyer, et al., 1998; Chereskin, et al., 1998; Kosro, et al., 1998).

IMPACTS/APPLICATIONS

The strong poleward flow at relatively shallow depths (100 to 300 m) over the inner continental slope off the west coast of the U.S. is persistent over both long space scales and seasonal time scales, even in a region with mean equatorward winds and near-surface currents. Poleward undercurrents seem capable of transporting bio-geo-chemical material over appreciable distances, counter to the prevailing winds and surface currents, and are involved in the formation of anticyclonic mesoscale eddies.

RELATED PROJECTS

The results should be of interest to those concerned with subsurface operations near the continental margins and to those concerned with fisheries. Poleward undercurrents, such as observed along the continental margin adjacent to the California Current, are common features of eastern boundary currents; a successful model of the flow regime along the eastern boundary of the ocean must take their presence into account. The monitoring program under US GLOBEC is conducting hydrographic and ADCP transects at several latitudes from 38°-45°N repeated five times per year; the present results provide a picture of the same processes central to that program, but at much higher spatial resolution.

ADCP, Miller Freeman, July 7 to August 2, 1998

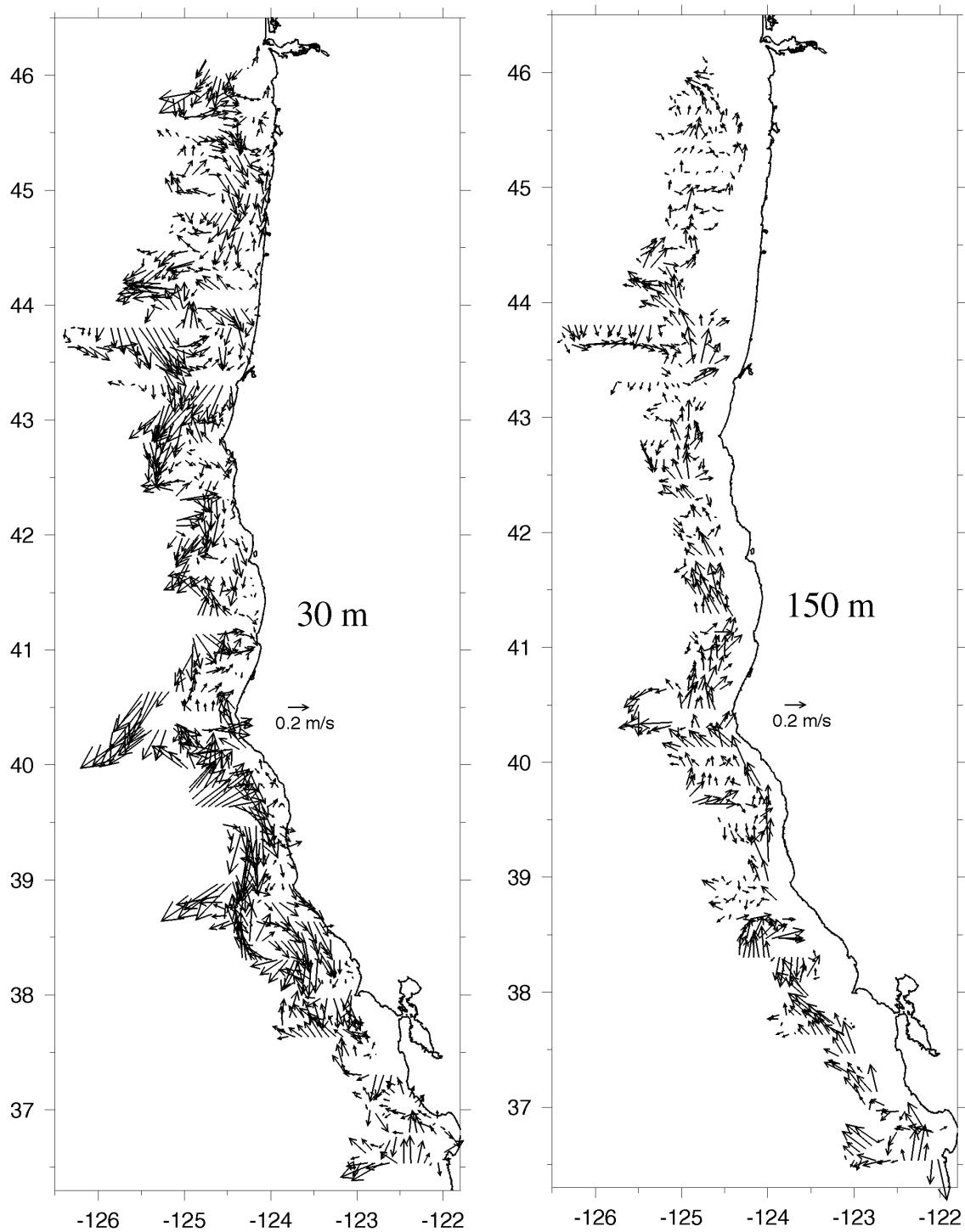


Figure 1: Currents at 30m (left panel) and 150m (right panel) measured during the 1998 Triennial Trawl Survey.

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